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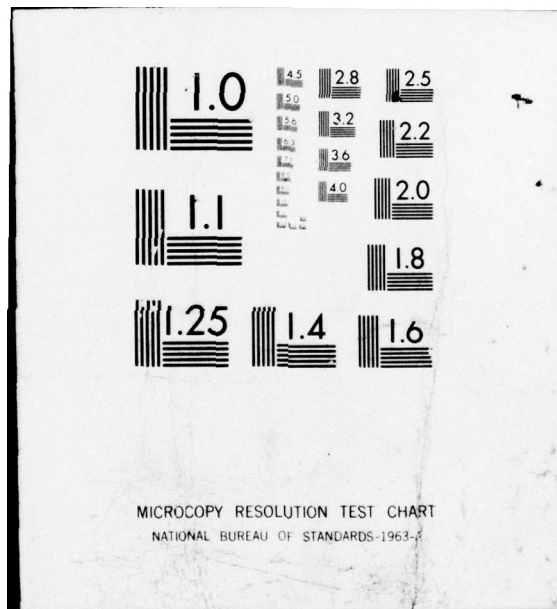
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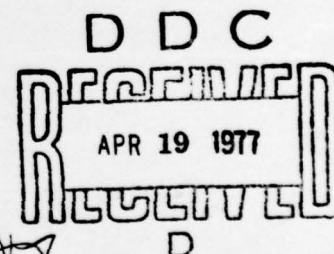
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EVALUATION OF V-51R AND EARtm EARPLUGS FOR USE IN FLIGHT

February 1977

Final Report for Period 1 January 1976-30 May 1976



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The voluntary informed consent of the subjects used in this research was obtained in accordance with AFR 80-33.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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20. ABSTRACT (Continued)

Discomfort due to the changing barometric pressure. This study suggests that the majority of our aircrews could wear either earplug in flight without difficulty, thus providing increased protection against the hazardous noise environments in which the aircrews must perform.

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EVALUATION OF V-51R AND EARtm EARPLUGS FOR USE IN FLIGHT

INTRODUCTION

Considerable interest has existed in qualifying and authorizing use of insert ear protectors during flight in high-performance aircraft. Current Air Force directives prohibit wearing earplugs under the flight helmet because of the decreased pressure which might occur between the tympanic membrane and the earplug during descent from altitude. This negative pressure can result in effects that range from barely noticeable pressure to extreme pain, and reportedly in rare cases to disorientation, vertigo, and general dizziness. A new foam earplug, the EARtm plug, has been suggested for use in flight. As a basis for its acceptance or rejection, the plug was evaluated at the USAF School of Aerospace Medicine to determine its suitability for inflight use, with the primary concern being the plug's ability to allow pressure equalization in the external auditory canal during altitude changes. The altitude and rates of altitude change included those relevant to both bomber/transport and fighter/trainer type aircraft. Both the EARtm and the currently operational V-51R earplugs (Fig. 1) were tested, with the V-51R serving as the basis of comparison. The earplugs were evaluated for short-term comfort, ease of use, and the ability of the plug to allow pressure equalization in the external auditory canal during both ascent and descent. This study did not attempt to evaluate attenuation features of either earplug.

METHODS

Thirty human volunteer subjects were properly fitted with both the V-51R and the EARtm earplugs, and instructed to wear the plugs until they became accustomed to their use. Prior to the altitude test flights using earplugs, the subjects' ability to ventilate their middle ears was determined by an ear and sinus check flight in the altitude chamber. The check flight consisted of ascent to 9,000 ft (2.7 km) at 4,000 ft (1.2 km) per minute, followed by descent to ground level at 8,000 ft (2.4 km) per minute. After successful completion of this check, the subject was instructed to insert a set of test plugs (half of the subjects began the test flights with the EARtm earplugs and the other half with the V-51R plugs) and was then placed back into the altitude chamber for the test flights. The altitude profile used in the test flights is shown in Figure 2. Each subject's external auditory canals and tympanic membranes were examined after each descent from altitude. After the first phase of the test flights, the original set of test plugs were removed, and the subject was instructed to insert the alternate set of plugs; the series of altitude exposures were then repeated. Subjects were instructed to insert the plugs at ground level and wear them throughout the ascent phase. Prior to descent from 9,000 ft, the seal of the earplug was checked.

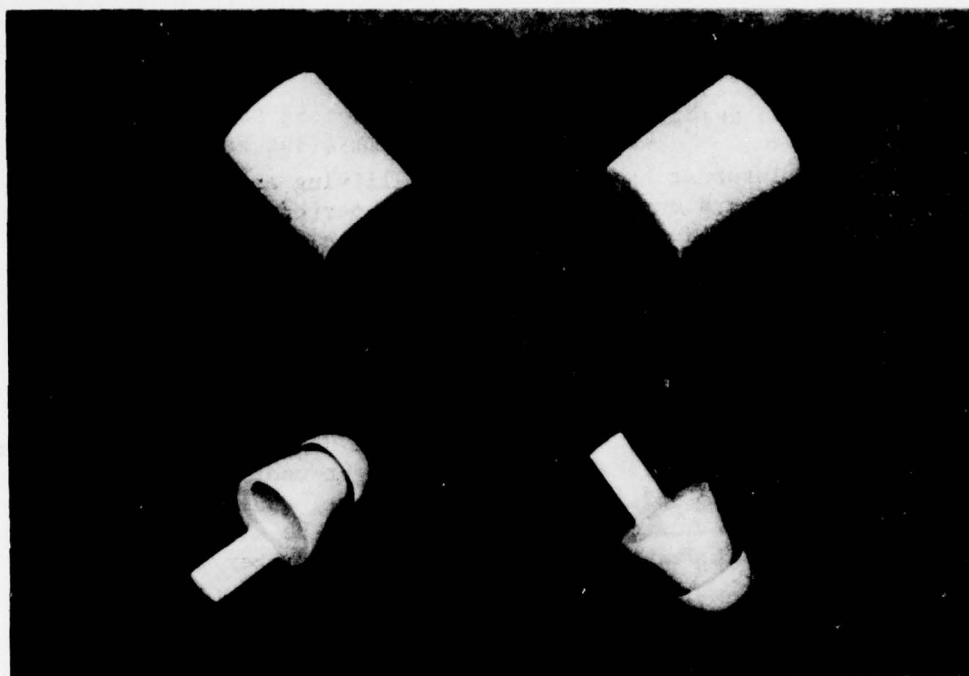


Figure 1. EARtm (above) and V-51R (below) earplugs.

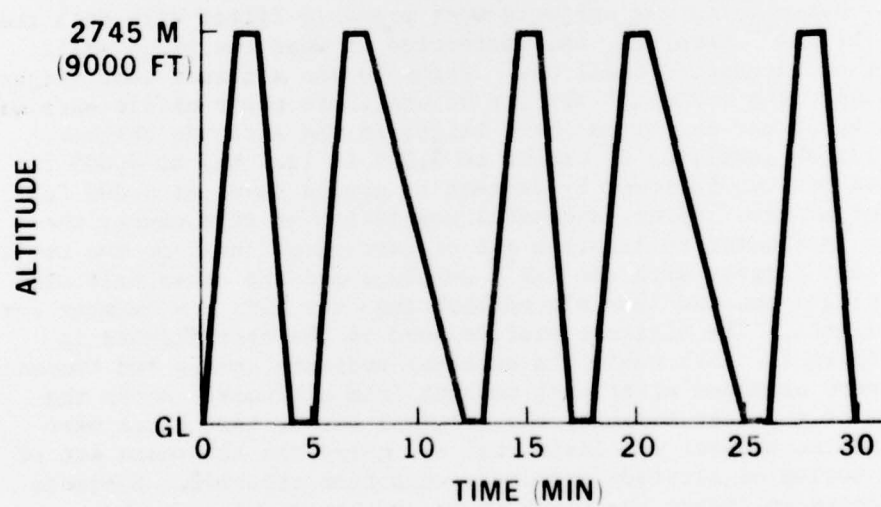


Figure 2. Altitude profile used in evaluating the EARtm and V-51R earplugs.

RESULTS

Comfort--Approximately half of the 30 subjects expressed preference for the V-51R earplugs; the remaining subjects reported the EARtm to be more comfortable. This included both ground-level and inflight comfort.

Ease of Use--All subjects reported that the 1-2 minutes required for the foam to reexpand during the insertion process with the EARtm earplug was excessively long, making its use somewhat awkward. One individual required assistance in removing the EARtm plugs from his auditory canals after descent in the altitude chamber. No problems were reported with the V-51R plugs.

Pressure Equalization--Regardless of earplug worn, all subjects completed the flight series without either ear pain or discomfort due to the changing barometric pressure.

DISCUSSION

Comfort is an important factor that may, by itself, negate the overall value represented by a particular earplug. Although comfort and other features related to general wearability can be explored in the laboratory, the true test is to be found in actual operational situations. Quite often comfort and general wearability features predicted from laboratory results do not correspond with actual findings obtained in the field. If earplugs are fitted properly, generally there are few complaints of discomfort among those who routinely wear them; however, among those who do not routinely wear earplugs, complaints of discomfort may be quite common. Even a well-fitting earplug is usually considered quite uncomfortable when first worn by a subject, but if he wears it routinely, he soon reports the plug as comfortable.¹ The EARtm earplug was neither more nor less comfortable than the V-51R plug.

All earplugs should be easy to handle, to insert, and to remove from the ear when no longer needed. Although these requirements seem relatively simple, they are not always satisfied. Negative factors to be considered with the EARtm plug are the long time required for the foam to reexpand during insertion, and the possible inability of a user to remove the plug without assistance.

Based on data from the chamber flights, the 95% confidence limits on the percent of subjects that would not experience difficulty in ventilating their middle ears are 90%-100%, and the 99% confidence limits are 84%-100%. These confidence limits allow for the possibility that some individuals would experience problems and should not wear earplugs in flight, especially under the flight helmet where the plugs are difficult or impossible to reach. More significant, however, this study suggests that most of our aircrews could, without difficulty, wear the earplugs in flight, thus providing increased protection against the hazardous noise environments in which the aircrews must perform.

1. Gasaway, Donald C. Personal Ear Protection, Aeromedical Review 2-71, USAF School of Aerospace Medicine, August 1971, pp 103-104.

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